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BOSTON UNIVERSITY OBSERVATORY

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TEKTITE PROJECT

MAY 1960 - MAY 1961

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by

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During the past year we have performed the second experiment in our solar furnace series. These experiments were carried out at the solar furnace at Natick, Massachusetts which provides a source of high intensity energy with no chance of contamination caused by the heat source. In our first experiment (Research Report No. 4) sediment found in a tektite field was fused to glass and an approximate value for the energy required to fuse the sediment was obtained. In this second experiment, we have been able to obtain a more accurate value for the energy required and in addition we have been able to obtain an estimate of the time required to fuse glass from the sediment as a function of the thickness of the glass. As a result, we can eliminate those theories of tektite origin which are unable to account for sufficient energy transfer to the sediment within a reasonable time.

We have also developed a self holder technique for our samples which, without resorting to costly platinum crucibles, enables us to obtain a glass free from contamination by the container. Details of the experiment are recorded in Research Report No. 6 dated January, 1961.

We are now well into an investigation of the aerodynamic properties of the australite flight form, using a plasma jet at the Avco Corporation's Wilmington, Massachusetts, facility. Our first experiment involved testing specially shaped samples made of australite glass. The frontal surfaces of these samples were ground to spherical shape. They were then placed in the arc jet and exposed at an equivalent flight velocity of from one to two miles per second.

Through methods devised in collaboration with the Boston University Computation Laboratory, a computer program was set up with which we are now able to determine accurately the curvature and eccentricity of the cross section of any surface for which we can provide the coordinates.

The frontal surfaces of the samples became parabolic within one quarter second after ignition of the jet, and the surfaces remained parabolic for the remainder of the run.

Coordinates for the cross section of the frontal surface of two flanged australite buttons were also fed into the computer and the results show that australites, too, have parabolic rather than spherical frontal surfaces. These surfaces have hitherto been referred to as spherical in the literature. (Memoirs of the National Museum of Victoria No. 23, "Tektites" by G. Baker.) No stable flange formation was observed. However, we do not preclude formation of a flange at different equivalent flight velocities or longer equivalent flight times.

A second experiment was performed at the Avco facility, to determine the effect of rotation upon tektite glass. We developed a rotating sample holder which endured the heat and mechanical stress for long periods of time. Seven specimens were heated in the jet with exposure times of from one to four seconds, and with rotational speeds between 500 and 5,000 rpm. Spraying occurred at all speeds of rotation and no flange was formed. We conclude that the australite flight form cannot be produced by rotation at velocities greater than 500 rpm.

Comparative chemical analyses were made of the sediments from Texas and Georgia and of the glasses made in the solar furnace from those sediments. Dr. Martha Thomas of Boston University has performed the analyses for us. The table below gives a preliminary analysis of the more important constituents.

	Georgia Sand %	Georgia Glass %	Texas Sand %	Texas Glass %
SiO_2	75.5	80.34	72.68	75.00
Al_2O_3	12.50	10.85	8.10	1.87
K_2O	.52	.54	1.16	1.31
Na_2O	.47	.51	.75	.75
TiO_2	.30	.18	.14	.17
Fe_2O_3+FeO	4.90	5.20	3.20	8.20
CaO	$<.10$	$<.10$	.34	.48
MgO	$<.10$	$<.10$	.51	.58
MnO	.0040	.0039	.0055	.0061

There is some doubt concerning the values of Al_2O_3 and the Fe oxides for Texas glass. These values will be checked in the near future.

Two grams of our Georgia tektite have been donated to the Smithsonian Institution. Their analysis of the material is still in process. Solar furnace glass and tektite specimens from several localities have been donated to Dr. Pinson of Massachusetts Institute of Technology for analysis.

One consequence of the solar furnace experiments was the need to determine accurately the bubble-free density of the glass produced. Comparison of this density with the gross density of the glass would provide a good measure of the bubble content of the glass. A determination of the range in densities of the various components within the glass would provide valuable information concerning the homogeneity of that glass.

To eliminate bubbles, a powder immersion technique of density measurement was developed which permits density measurements to be made with four decimal place accuracy. Briefly, the material is immersed in a heavy liquid whose density is adjusted to that of the material by addition of a lighter liquid. When the density of the liquid equals that of the material, the material remains suspended in the liquid. The density of the liquid may now be measured accurately using standard techniques. The density of the material in a bubble-free state is obtained by powdering it. The gross density of the material is obtained by suspending it unpowdered in the liquid medium. Comparison of the powder density with the gross density yields the bubble content. By changing the density by known steps the range of densities in the material may be obtained.

Glass produced in the solar furnace had a gross density of 1.980 gm/cm^3. However, the powder density of the same material averaged 2.290 gm/cm^3. The density of the powdered glass places the glass within the range of densities found in tektites. We used the same procedure to measure the bubble content in certain tektites and found that the bubble content affected the density only in the second decimal place.

The density spread of the solar furnace glass was from 2.150 to 2.295, or a difference of .145 gm/cm^3. We believe that the spread is due chiefly to the presence of tiny bubbles of varying sizes in the powder grains. We have examined the powder through the microscope and have found that even the smallest powder grains still contain bubbles. We conclude that the energy of fusion obtained in the solar furnace experiments must be close to the minimum necessary for fusion since the glass has not become sufficiently fluid to become free from bubbles.

If a tektite is to be made using a sediment as a raw material, the energy supplied must be greater than that supplied during the experiments. Otherwise, the resulting glass will not have the homogeneity of density and relatively bubble-free texture characteristic of most tektite glasses. Few natural sources can provide the necessary energy input within a reasonable time. The most important possible energy source to consider is impactite and thus far little evidence exists connecting known tektite strewn-fields with meteorite falls. A complete report of the procedures and techniques employed for our density measurements is found in Research Report No. 7.

An unusual sample of rock was sent us from the Abbey Dawn together with an eye-witness description of its formation by lightning. Samples were sent to the U. S. Geological Survey for analysis. It was found to be composed chiefly of iron compounds ordinarily found in the earth and in view of the chemical analysis we conclude that there is no connection between this material and tektites.

We have studied certain reports pertaining to the geology of Massachusetts and we believe that Martha's Vineyard is not the only locality in the area having sediments of the same age as that upon which tektites have been found. We have made survey trips to the areas around Scituate, Duxbury and Kingston, Massachusetts and we have been following a program intended to alert interested parties in those areas to the possible existence of tektites in their neighborhoods. Several objects have been brought to us for examination but no tektites have been found. A thorough search of the area on Martha's Vineyard where a tektite was found in 1959 was made from July 24 through July 26, 1960. No tektites were found. The geology of this area is not yet completely known and it may be said definitely that no correlation with the age of the sediments and the age of the tektite found there may be made. The tektite was found lying in a ravine into which material from many geological ages was carried.

Evidence obtained from the solar furnace experiments has virtually eliminated the possibility of a terrestrial origin for tektites. Our two plasma jet experiments have indicated that tektite material is well able to survive entry into the earth's atmosphere.

The work of Dr. D. R. Chapman in the same field points to the importance of continuing aerodynamic research and to an eventual solution of the problem of tektite origin. Although we agree that tektites are probably of extraterrestrial origin, we cannot as yet accept his hypothesis that meteorite impact on the moon is the original source for tektites found on earth.